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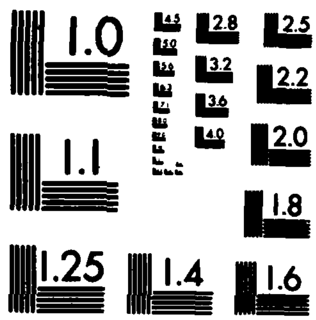

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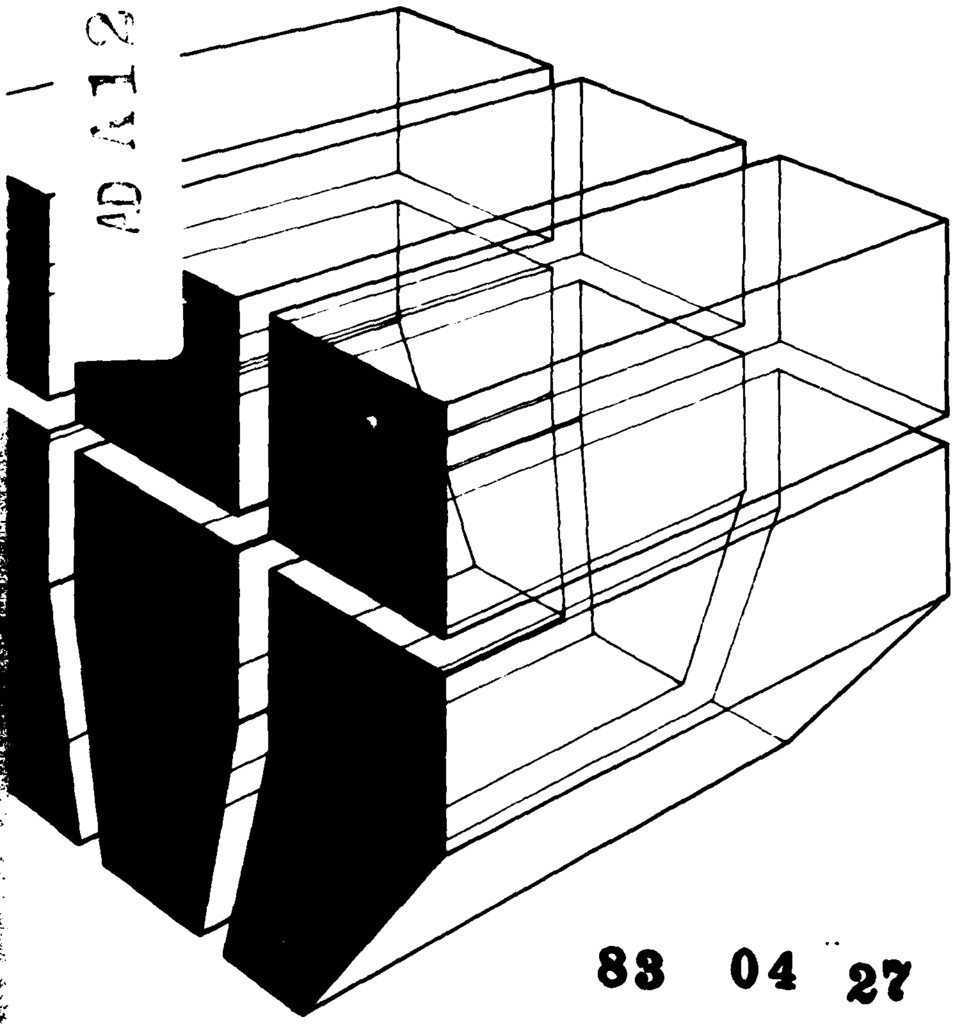
Technical Report N-144
January 1983

Environmental Early Warning System

THE ENVIRONMENTAL EARLY WARNING SYSTEM (EEWS): CONCEPT DESCRIPTION



by
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This report gives a concept description of the Environmental Early Warning System (EEWS) developed by the U.S. Army Construction Engineering Research Laboratory (CERL). The EEWS is an interactive computer system designed to give the Department of Army Headquarters and Major Command planning and decision-making personnel a way to quickly find potential environment-related problems associated with proposed changes in troop strength, mission, facilities, natural resource management, and land use. The system is designed to help Army managers during the earliest stages of Army planning and is

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not a substitute for current planning methods or Environmental Assessments or Impact Statements. Included are a system description from the user's point of view, a brief explanation of how the system calculates results, and descriptions of the system's tabular and location-specific data handling capabilities.

FOREWORD

This work was conducted for the Assistant Chief of Engineers under Project Number 4A762720A896, "Environmental Quality Technology"; Task C, "Command Environmental Planning Strategy"; Work Unit 005, "Environmental Early Warning System." The applicable QCR is 3.01.002. Mr. G. Robinson, DAEN-ZCE, was the Technical Monitor.

This investigation was performed by the Environmental (EN) Division of the U.S. Army Construction Engineering Research Laboratory (CERL). Dr. Harold Balbach was Principal Investigator. Appreciation is expressed to Mr. J. Westervelt, who contributed extensively to the planning and execution of this work. Dr. Ravinder K. Jain is Chief of CERL-EN.

COL Louis J. Circeo is Commander and Director of CERL, and Dr. L. R. Shaffer is Technical Director.

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THE ENVIRONMENTAL EARLY WARNING SYSTEM (EEWS): CONCEPT DESCRIPTION

1 INTRODUCTION

Background

Along with the Bureau of Land Management and the National Forest Service, the Army is one of the nation's largest managers of public lands. It is part of the Army's national defense mission to keep these lands in good condition so they can be used for the training, development, and testing that will insure the armed forces are ready to meet any outside threat to the nation's security. Because these training lands—more than 12 million acres of mostly undeveloped forest, range, and desert—are an irreplaceable resource, the Army must preserve the quality of their natural environment.

The National Environmental Policy Act (NEPA) and Army Regulation (AR) 200-2 mandate that the Army consider environmental quality at the earliest concept stages when planning to expand or change training, management, support, or strength programs on its installations.[1] Until recently, the Army had no way to measure the impact of such changes on an installation environment until after much of the planning was complete and enough data were collected to allow an Environmental Assessment (EA) or an Environmental Impact Statement (EIS) to be written.

If an EA or EIS uncovers an environmental impact problem, the problem usually can be resolved by adjusting the Army's proposed program. But, in a very few cases, a serious conflict is found. Serious environmental problems which surface late in the Army's planning process during peacetime force program changes that are expensive and that may jeopardize the Army's ability to fulfill its national defense mission.

Thus, the Assistant Chief of Engineers for the Environment asked the U.S. Army Construction Engineering Research Laboratory (CERL) to develop a method the Army could use to flag potentially serious environmental problems very early in the Army's planning process.

[1] The National Environmental Policy Act of 1969, PL 91-190, 83 Stat 852; *Environmental Effects of Army Actions*, Army Regulation (AR) 200-2 (Department of the Army, 1 September 1981).

Objective

The objective of this work is to develop a method Headquarters, Department of the Army (HQDA), and major command (MACOM)* personnel can use to identify potentially serious environment-related problems associated with changes in troop strength, mission, facilities, natural resource management, and land use. This report gives a concept description of the early planning method developed by CERL: the Environmental Early Warning System (EEWS).

Approach

During 1979, the U.S. Army Training and Doctrine Command (TRADOC) and the U.S. Army Forces Command (FORSCOM) listed and ranked a limited number of environment-related problem areas. Based on this list, CERL developed a planning approach to help TRADOC and FORSCOM identify and avoid, during early planning stages, highly ranked problem areas. This approach was then adapted to a computer system which used equations to manipulate stored planning data using a modular framework.

Scope

This study did not attempt to consider changes in current planning methods or impact quantification normally addressed by EAs and EISs. EEWS addresses planning considerations at a much earlier stage. Since the user inputs are minimal at this stage, the ouputs must be generalized. Therefore this system is not intended to replace the work done by the installation Facility Engineer, particularly detailed site studies. Rather, EEWS will give higher level decision-makers more and better data to evaluate alternatives much earlier in the planning process.

Mode of Technology Transfer

The results of this study will be transferred in accordance with AR 18-1, *Army Automation Management* (Department of the Army, 15 August 1980).

2 SYSTEM OVERVIEW

General

Almost any new action taken by the Army at an installation will affect, or impact, the environment. For

*MACOMs for which the system will be developed are the U.S. Training and Doctrine Command (TRADOC), the U.S. Army Forces Command (FORSCOM), the Materiel Development and Readiness Command (DARCOM), and the National Guard Bureau (NGB).

example, a new type of training may require an artillery range be built in an area populated by an endangered species or an increase in troop strength may mean both new construction and a change in the nature of the housing and economy in the communities near the installation. Sometimes these activities will change the quality of an environment in a positive way; for instance, when new jobs and commerce are brought to the civilian community. Sometimes they may affect the environment in a less welcome way, as when the habitat of a rare or endangered plant or animal species is disturbed.

With careful planning, environmental quality considerations can be incorporated alongside Army mission goals without sacrificing either Army readiness standards or environmental quality. It has been the Army's experience that only occasionally do Army activities and environmental considerations conflict seriously enough to jeopardize a proposed action or the military's ability to fulfill its readiness mission. Most of these serious conflicts are encountered when a change in an installation's activities disrupts traditional land-use patterns.

EEWS Rationale

The EEWS is designed for use during the earliest stages of Army planning, even before actions are considered for the first phases of site analysis or project implementation.

At this stage, Army planners (often at the MACOM level) say, in effect, "What if this unit–or school, function, activity–were taken from Installation A and moved to Installation B?" This type of "what if" planning is vital if the Army is to make sure it is using its installations' limited resources in the best way. It is a dynamic, ongoing process because Army training needs (both in tactics and weapons systems) are continually in flux, responding to new situations in the "threat" environment, advances in military technology, changes in troop strength, etc.

The Army's planning situation is not unique. Such "what if" scenarios are common to all planning in large organizations. The difference is the size and scope of the Army's planning task and of the special responsibility it has in the area of environmental quality.

EEWS Concerns

The EEWS restricts its concerns to factors which have, in the past, actually caused a delay or reconfiguration of an Army action. Thus, the EEWS does not introduce a new information element to current "what if" planning, but automates the process of sorting, comparing, and projecting "what if" scenarios, with results equal in quality or better than those now available at this stage of the planning process. The EEWS consolidates the Army's current data on environmental impact and eliminates the need to hand-tabulate these data. The result is that more "what if" alternatives can be considered by Army planners, improving the speed, efficiency, and quality of the entire planning process.

The EEWS concerns were assembled from a list of important environment-related issues compiled and ranked by TRADOC and FORSCOM personnel and from other data collected from HQDA and MACOM files. The system was designed to handle these concerns under the following assumptions:

1. All Army units contain personnel in the numbers associated with the current Tables of Organization and Equipment (TOE), strength level 1.

2. Units are actually equipped with the weapons and support items associated with that unit and will use those weapons, vehicles, and other support items on the installation in question to complete the Army Training and Evaluation Program (ARTEP) tasks appropriate to that unit.

3. Students will follow the appropriate Program of Instruction (POI) leading to the Military Occupational Specialty (MOS) sought by the training program.

4. Personnel transferred to an installation will cause demands within several categories of on- and off-installation resources (e.g., BEQ, Officer's Family Housing, civilian apartment rental) in a pattern similar to those personnel now stationed at that installation who are comparable in rank, marital status, and general lifestyle.

DARCOM considerations will also be developed. The concept is similar, though the manipulations would have to be DARCOM-unique. For example, demand would be generated by moving projectile manufacture production lines among DARCOM installations. Demand might be for increased labor force, raw materials, or impacts caused by changes in wastewater or air pollution.

The EEWS Data Base

The EEWS uses two kinds of data: global and local. Global data are independent of a particular installation. Local data pertain to a specific installation.

Because of the large amount of data needed by the EEWS and because these data must be consistent to insure the system's equations will deliver useful results, any data source used for the EEWS must allow data to be collected from it efficiently and, wherever possible, in computer-readable form. This requirement means it is best to take most EEWS data from HQDA sources (Table 1). Although installations have the most detailed data about themselves, these data are not consistent among installations. And although MACOMs have many ways of collecting and standardizing installation data, there may not be any consistency among MACOMs in the way these data are recorded. The EEWS uses MACOM-level data sources if possible, because of the better detail available. When MACOM-level data are not available in an acceptable form, the EEWS uses HQDA-level data. The advantages of using HQDA-level data sources include:

1. Data reporting forms and definitions are standard.

2. Data reports are more likely to be in computer-readable form.

3. Data for input to the EEWS database are available from a single source.

Disadvantages include:

1. Data are often summarized, losing important details that could be gotten from MACOM- or installation-level data. Condensed data also are less likely to be useful as raw data.

2. Data tend to lose accuracy as they are aggregated up the chain of command.

3. Army-wide data are more likely to be classified.

Table 1
Typical Sources of the EEWS Data

1. IFS (I) Integrated Facility System.
2. Emergency Expansion Capability Master Plans.
3. Analysis of Existing Facilities/Environmental Assessment Report.
4. Military Markets Facts Book.
5. Domestic Base Factors Report.
6. Housing Operations Management System (HOMES).
7. Tabulation of Existing and Required Facilities (TAB).
8. Stated Installation/Division Personnel System (SIDPERS).
9. DD Form 1377-78, Family Housing Reports.
10. DD Form 1657, Bachelor Housing Requirements.
11. TRADOC or FORSCOM Form 244R, Installation Range Requirements.
12. Facility Engineers Yearbook.

EEWS Applications

The "what if" scenarios modeled on the EEWS usually fall into two mission realignment groups: Trial Fit or Musical Chairs.

In Trial Fit planning, several installations are considered as sites for a new unit or function. For example, a planner may ask "Where can Unit A be placed after it returns to CONUS from an overseas location?"

In Musical Chairs planning (probably the more common type of "what if" planning), several installations are considered as sites for balancing the demands of units or functions to allow more efficient operations. Musical Chairs planning usually has two results:

1. *Surpluses*. The space vacated by units or functions at the "losing" installation is available for other functions, or for surplusing.

2. *Deficits*. Units or functions moved to a "receiving" installation demand space or special facilities. These transferred units or functions may displace other units, which are then sent to another location.

Thus, a single Musical Chairs question may lead to interlocking questions involving three or more locations or "what if" scenarios with complicated distributions of surpluses and deficits. The best situation usually balances surpluses and deficits.

Using the EEWS, planners can construct and evaluate Trial Fit and Musical Chairs scenarios and identify, within minutes, possible serious environmental conflicts any individual (or combined) scenario will cause.

The EEWS can be used to do early-stage planning for relocating any FORSCOM unit in the current TOE and any TRADOC class or POI. The EEWS also can evaluate nonstandard inputs for nonorganizational units, unique units, tenants, and individuals or groups not covered by standard personnel numbers or grades.

3 THE EEWS FROM THE USER'S POINT OF VIEW

The EEWS is interactive, versatile, and easy to use. The user does not have to learn any special computer language, since all the system's commands are in English.

The EEWS will literally teach the user how it works by coaching h: n* through a series of questions about what he needs to know. Thus, the EEWS user needs no special training; the first time he accesses the EEWS, he will be able to input data and receive results.

Different self-teaching options are available from the EEWS, depending on the response the EEWS expects and whether the user is a beginner, advanced, a technician, or a researcher. The system will tailor the length and technical nature of its questions to the user's skill level.

Accessing EEWS

The EEWS operates on a portable terminal (Texas Instruments Silent 700 or equivalent) tied to the EEWS central computer via a telephone acoustic coupler.

To access EEWS, the user must logon with his user identification and password. These will identify the user's skill level, allowing the EEWS to switch to the appropriate self-teaching mode. The EEWS then will ask the user what types of environmentally related questions he wants to investigate.

The EEWS Capabilities

The EEWS user may select from two EEWS capabilities, depending on the type of scenario he wants to model and the kind of output he needs.

The Tabular Environmental Early Warning System

The Tabular EEWS output reports are tables, or lists, of information which show how current strengths, training, land uses, etc. at the user's selected Army installations would change if the user's "what if" scenario was implemented.

The Tabular EEWS has two parts:

1. Files containing data which characterize the current status of Army installation strengths, missions, training, facilities, natural resources, etc. The Assigned Responsible Agency (ARA) will carry out the updates. Updates can occur as often as new data become available.

2. Equations which break down the user's "what if" scenario into a series of algebraic steps. Equations are associated with topic areas (Table 2).

*The male pronoun is used throughout this report to refer to both genders.

Table 2
A List of Possible EEWS Topic Areas

Rare and Endangered Species
Environmentally Sensitive Lands
Housing
Community Services–Dependent Schools
Energy Demand Changes
Culturally Sensitive Lands
Ranges
Ammunition Storage Changes
Transportation
Maintenance Areas
Fuels, Vehicles, and Aircraft
Utility Concerns
Noise Considerations
Off-Post Impacts
Retail Services
Medical and Hospital Facilities
Uniquely Dedicated Areas
Recreational Facilities
Food Supply Facilities
Storage
Transportation Needs
Administrative Facilities
Community Services
Operational Areas (excluding ranges)
Air Considerations
Water Considerations
Training Facilities

To use the Tabular EEWS, the user gives the system the details of his "what if" scenario. (For example, the user may want to move a tank battalion from Installation A to Installation B.) Next, the user selects those topic areas in which he is interested; i.e., to see if his "what if" scenario may cause environmental problems (for example, the topic areas Housing or Rare and Endangered Species.) The Tabular EEWS then takes the scenario information, implements the modeling equations appropriate to the user's topic areas, runs a modeling session, and outputs the results.

The way in which the Tabular EEWS' computer program cross-references and catalogues topic data is complex; the program's actions in calling and implementing equations within a modeling session are also very complicated. But the Tabular EEWS user does not have to worry about the computer program's structure: to get accurate results, he only has to give the Tabular EEWS his "what if" scenario information and then select his topic areas.

Figure 1 shows a typical scenario input session of Tabular EEWS. Figure 2 shows a topic-selection session. Figure 3 is an example of one of the Tabular EEWS output reports.

SIGN-ON

```
 81/10/01  09.03.04.
ARSI 1750.N0501.39 N 81/09/27 LS-U 02.02.44. ...0/30.
[redacted]
TERMINAL      373, TT:
RECOVER/USER ID: cer.

N>-ews

OPTION?
I>model

ARE THE SAME MOVES TO BE MADE AT ALL INSTALLATIONS?
I>no

INSTALLATION?
I>ord

UNIT TYPE?
I>55

NUMBER?
I>-1

UNIT TYPE?
I>60

NUMBER?
I>-1

UNIT TYPE?
I>63

NUMBER?
I>-2

UNIT TYPE?
I>12

NUMBER?
I>1

UNIT TYPE?
I>13

NUMBER?
I>1

UNIT TYPE?
I>15

NUMBER?
I>5

 I>exit

INSTALLATION?
I>wood

UNIT TYPE?
I>55

NUMBER?
I>1

UNIT TYPE?
I>60

NUMBER?
I>1

UNIT TYPE?
I>63

NUMBER?
I>2

UNIT TYPE?
I>exit

INSTALLATION?
I>exit
```

MODEL

INPUT

ENTER USER NUMBER.
ENTER PASSWORD.
(obtain from CERL).

The user may place any short identifying abbreviation here, in this case "CERL" was input.
To access interim EMS type "-ews". It takes about a minute for the word OPTION to appear.

Type a "?" in order to see what is available. If *at any time* you are in doubt as to how to respond, you should type in "?" for more information.

PURPOSE

Since we are interested in modeling the effects of moving personnel among two installations, we enter "model".

We are making different moves at different installations. We answer "no".

Abbreviated installation names are the ones which must be used in answering the question. "ORD" is an acceptable answer while "FORT ORD" is not.

We enter "55" since we are interested in moving an engineer battalion from Fort Ord.

We enter "-1" since we are interested in moving 1 engineer battalion *out* of Fort Ord.

SE1

Figure 1. A Tabular Environmental Early Warning System scenario input example.

```
REPORT NAME?        (The user wishes to inspect a particular
I>topic              area of investigation rather than everything)

AGGREGATION?        (Request a list of those areas of investiga-
I>?                  tion currently available to a user)

VALID ANSWERS:
HOUSING
DEP SCHOOL
MEDICAL
UTILITIES           (List of topic area abbreviations)
RANGES
RARE&E SP
HISTORICAL
ARCHEOLOG
WATER BOD

AGGREGATION?
I>?

THE FULL NAMES FOR
THE AGGREGATIONS ARE:

 HOUSING
 PERSONNEL AND DEPENDANT
 HOUSING REQUIREMENTS

 DEP SCHOOL
 SCHOOL STUDENT PLACES FOR
 MILITARY PERSONNEL CHILDREN

  MEDICAL
  MEDICAL CONCERNS

  UTILITIES
  UTILITIES                        (Explanation of abbreviations)

  RANGES
  FIRING POINTS, RANGES,
  IMPACT AREAS

  RARE&E SP
  RARE, ENDANGERED
  AND THREATENED SPECIES

  HISTORICAL
  HISTORICAL

  ARCHEOLOG
  ARCHEOLOGICAL

  WATER BOD
  SENSITIVE AREAS DUE TO
  PRESENCE OF WATER BODIES
```

Figure 2. A Tabular Environmental Early Warning System topic selection example.

The Location Environmental Early Warning System

In environmental planning, many questions can only be studied if a concern's location, or "nearness," to critical considerations is known. The Location EEWS concept is similar to the Tabular EEWS, but its output is presented as maps (with supporting information in tables). The Location EEWS allows a user two broad capabilities:

1. The user can quickly display maps for selected categories of data for many installations.

```
AGGREGATION?
I>rare&e sp
```

TOPICAL NEW SURPLUS

RARE, ENDANGERED AND THREATENED SPECIES

DESCRIPTOR	ORD	WOOD
R&E CONF P	PRESENT	0.00
R&E LIK P	PRESENT	PRESENT
R&E POS P	PRESENT	PRESENT
R&E MC P	0.00	0.00
R&E CONF S	PRESENT	0.00
R&E LIK S	PRESENT	0.00
R&E POS S	PRESENT	0.00
R&E MC S	PRESENT	0.00

Figure 3. Example of a Tabular Environmental Early Warning System output report.

2. The user can manipulate and combine maps to analyze complicated natural resource or land use questions. Mapped data can be combined to determine critical distances among complex groupings of items, to find desirable areas for a new land use, to determine the degree of impact resulting from various alternative land use relations, and to present simple statistical information about locational relationships.

Modeling Options

In both the Tabular EEWS and Location EEWS, the user has two modeling options. The easiest, and most common, is to let the systems' predefined equations model "what if" scenarios based solely on simple user input; i.e., the user does not change any standard Tabular EEWS or Location EEWS modeling equation.

The other option is mostly reserved for researchers. This option lets the advanced user who has extensive system knowledge change modeling equations or create new ones.

The Tabular Environmental Early Warning System/ Location Environmental Early Warning System Connection

The EEWS is unique because its tabular and locational capabilities will be linked to give the entire system far more power than the sections would have if they stood alone. The large amount of stored data needed to run the Tabular EEWS is no more than a

summation of the Location EEWS' spatial data or analyses. If a user finds from the Tabular EEWS the *amount* of a problem, he can immediately use this quantified knowledge in a Location EEWS analysis to find the extent or *location* at which it will occur. The hybrid EEWS available by integration will allow environmental questions to be investigated in greater detail and much earlier in the planning process than was ever before possible.

4 THE TABULAR ENVIRONMENTAL EARLY WARNING SYSTEM: AN OVERVIEW

User Input

The Tabular EEWS is designed to give the user the best information about the effects of his "what if" scenario with the simplest input possible. When a user considers a realignment or investigates a mission change, the least common denominators for his inputs fall into two groups:

1. Different grades and classifications of individuals.

2. Groups of individuals and their associated equipment (Army units) as in Figure 1.

Individuals can be moved by giving the computer a code number which references the grade level the user wishes to move and the number of individuals of that grade to be moved.

Individuals can be assumed to demand characteristic quantities of material and carry on the lifestyles characteristic of their grade. For example, 35 percent of all enlisted persons of Grade 4 will be married, their households will consist of one or more adults and 1.2 children, and each married enlisted person's household will demand 175 gal of residential potable water per day. When a user asks that 100 enlisted people of Grade 4 be moved into an installation, he may reasonably expect that 35 of the 100 will be married (2 adults per household), that 42 children will soon be making demands on local school systems, and that 6,125 gal more water per day will be needed for these families (plus that water demanded by the 65 remaining bachelors).

This example is very simple—a user can figure the answer in his head. But most moves are much more complicated. For example, assume different numbers of enlisted people of Grade 4 are moved, compared to those who are to be moved at enlisted Grade 5. Officers of Grade 2 may also be removed from the installation. It would be difficult for a user to collect current data on the percent married, number of children per household, number of gallons per day per household or per bachelor for all grades of enlisted people and officers. And even if the user had these data, calculating an answer would be complex and tedious, even using a calculator. Consider that each topic area in the Tabular EEWS often has tens of descriptors, each needing its own, often lengthy, equation. Immediately, one recognizes that the task of collecting and manipulating the quality and quantity of data required for the Tabular EEWS is overpowering. Further, troop reallocations or mission changes are not considered in terms of moving *individuals*. Rather, changes are complicated conglomerations of people, equipment, and other supporting characteristics—Army *units*.

Conceptually, moving Army units is no more difficult than moving individuals—it takes only one more step within the computer. To move units, the user picks out a code number (as he does to move individuals). That number refers to the file within the computer database which stores the number of enlisted persons and officers of different grades associated with the identified units (see the bottom half of Step 1, Figure 4). These then become the equation inputs in exactly the same manner as the inputs required for moving numbers of individuals. Other characteristics also are asssociated with units. An Attack Helicopter Company has 21 aerial guns associated with it, while a recognized infantry battalion will have 13 mortars and 18 TOWs. Each of the mortars does not demand a range; maybe one range can serve three mortars. This is conceptually the same type of demand as one family demanding 175 gal of water per day. The following equation could be used to calculate the total family demand for the water (see Step 2, Figure 4):

$$\text{(number of families moved)} \times \text{(175 gal/day/family)} \qquad \text{[Eq 1]}$$

The demand for mortar firing points can be calculated similarly:

$$\text{(number of mortars associated with the unit moved)} \times \left(\tfrac{1}{3}\text{ new range per mortar}\right) \qquad \text{[Eq 2]}$$

The file which contains information about units (whether they are Army units or individuals) can be expanded to include whatever input categories are

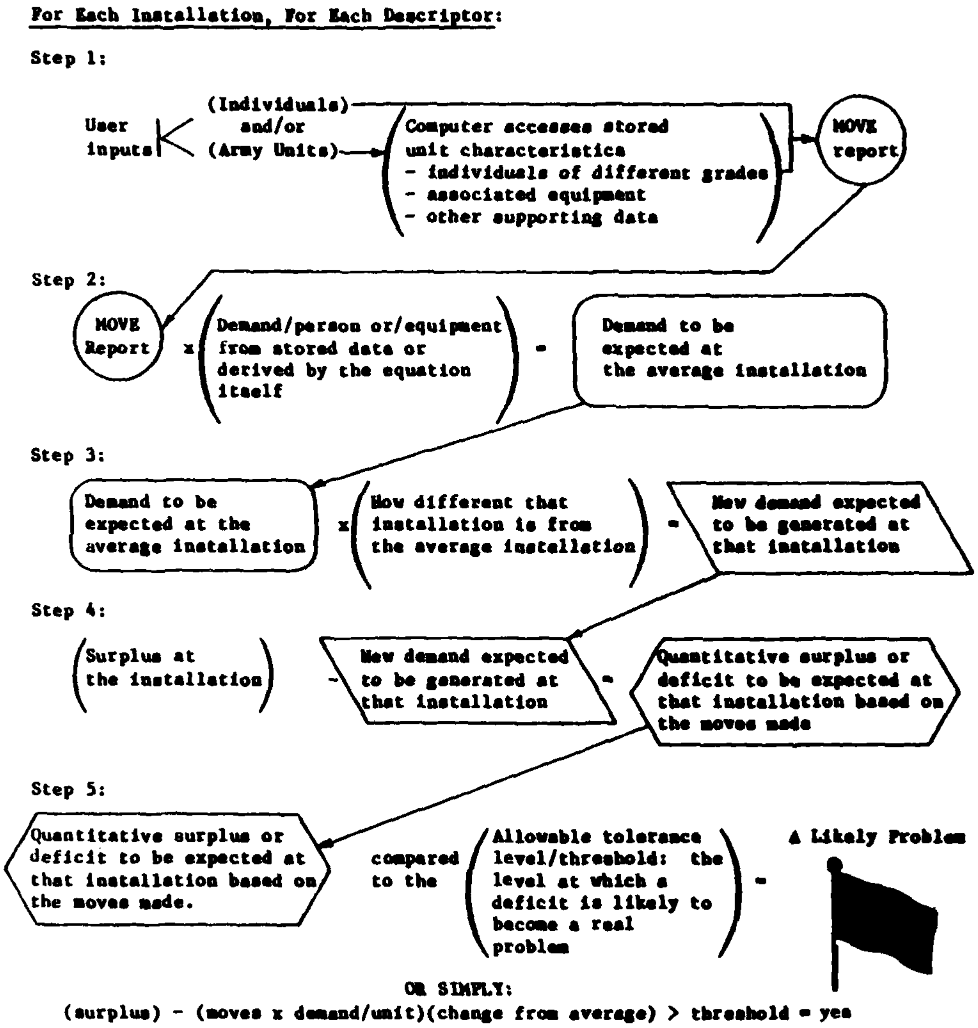

Figure 4. Concept diagram of the Tabular Environmental Early Warning System equation approach.

necessary to support an equation. For example, gas masks, mess kits, washwater (rather than potable water) may need to be considered when moving an Army unit.

In the Tabular EEWS, the starting point for a unit's characterization is its TOE. TOEs are independent of installations and contain detailed, theoretical strengths of personnel and equipment which are not classified.

If the user wants to model the effects of moving a particular, classified unit from one installation to another, this "what if?" scenario could be considered by associating that classified unit with its corresponding TOE description. The desired move then could be modeled and the unclassified result reported to the user. Nonstandard units can be formed by modifying existing units or by building them from the desired amounts of people and equipment.

Development, Maintenance, and Use of the Tabular Environmental Early Warning System

The Tabular EEWS data and equations are stored and manipulated within a hierarchy of specificity. But the most detailed level a user would ever encounter is

the result of an equation, called a "descriptor." A group of descriptors relating to one area of concern (e.g., rare and endangered species) is called a "topic area." Most users will want to ask for Tabular EEWS output by topic area.

The Tabular EEWS is designed to interface with three types of users: researchers, technicians, and the field users. The researcher's job is to develop and write the Tabular EEWS equations. Technicians load these equations and supporting data into the system. The field user will see only the output resulting from the manipulations done by researchers and technicians.

The description below outlines how researchers and technicians interface with the Tabular EEWS. This description is given only to fill out the concept description of the system. The field user does not need this information to model a "what if" scenario on the system.

Equation Format

The Tabular EEWS' equations are composed of operators and terms. In a single equation, there can be hundreds of terms and an unlimited number of operations.

Operators can include any basic algebraic manipulators: addition, subtraction, multiplication, division, and exponentiation, plus logical tests. The priority in which operations are carried out follows standard algebraic rules: first exponentiation, then division and multiplication, followed by subtraction and addition.

Terms are simply pieces of data stored in large computer tables (data files).

Developing the Tabular Environmental Early Warning System's Equations

When developing an equation for the Tabular EEWS, a researcher studying a topic area is responsible for formating his investigation results into a Tabular EEWS equation and for identifying a source for the equation's supporting information. Since equations and supporting data are so intertwined, they are investigated together and developed based on what is known about each.

The researcher initially is faced with a word description of the problem. First, the word description is divided into parenthetical phrases (Figure 5). In a series of ever-more detailed equations, this word description is translated into an increasingly pure algebraic equation.

During equation development, a researcher gathers much subsidiary information which cannot be used directly in the equation, but which is valuable. Such

General (% of Ranks in Family Housing at Installation A) x (Proposed Change x % of all Families of That Rank + Surplus)

Specific (Proportion of Ranks E4-E6 Families in 1-2 Bedroom Homes at Installation A) x (Change in Number of E4-E6 Families x Proportion of E4-E6 Families in 1-2 Bedroom Homes + Housing Category Surplus)

Sample Subgroup A (Proportions of all E4-E6 Families in 1-2 Bedroom Homes at Installation A) x [(- Change in Number of E4-E6 Families at Installation A)... etc.]

Sample Subgroup B (Proportion of all E4-E6 Families in 1-2 Bedroom Homes at Installation A) x (Change in Number of E4-E6 Families in 1-2 Bedroom Homes on and off Installation A ... etc.

Sample Subgroup C (Number of E4-E6 Family Homes With 1-2 Bedrooms Needed on Installation A .... etc.

Figure 5. Example of first steps in developing Tabular Environmental Early Warning System equations.

information is documented in the researcher's notes. For example, a researcher may find criteria or data sources which are not useful to his problem, but which may help in some research on a related topic area. Or sometimes the researcher finds two sets of criteria. In this case, he documents the reasons why one set was chosen over another. Research which resulted in dead-ends is also documented, so other researchers do not retrace those steps. Finally, equation assumptions are explicitly stated and stored.

After the equation is developed on paper, it is ready to be input to the computer along with a large volume of supporting documentation.

Data Files

There are four types of data files in the Tabular EEWS:

1. The file called UNITYP lists characteristics of each type of standard Army unit (e.g., an Attack Helicopter Company).

2. Each installation has an INSTL file. This file stores data associated with and specific to an installation (e.g., Fort Ord's information is stored in the INSTL file called ORD).

3. Sometimes no installation-specific data are available or the data are classified. In this case, the Tabular EEWS uses an Army-wide average from a file called TYPICAL.

4. Occasionally, no installation-specific data are in an installation's INSTL file, nor is an Army-wide typical amount stored in the TYPICAL file. The system then uses the AVE file, which contains a number which is the average of all the other installations currently in the Tabular EEWS for that entry.

Equation Example

An equation can take any form necessary to suitably detail the descriptor being investigated. To discuss how the Tabular EEWS generates results and to see how each part fits into the method, the conceptual steps of an example equation have been diagrammed in Figure 4. Remember that Figure 4 and the following discussion demonstrate only one possible equation among an unlimited population.

How are environmental effects culled from the extremely simple user inputs? As stated, the user gives the Tabular EEWS a series of numbers which represent changes in either individuals or equipment or both. This can be done for as many moves as are necessary for his "what if?" scenario. The inputs are used in an equation to generate the projected installation demands using (conceptually) a series of steps (i.e., different sections of the equation). One section takes the characteristics of the unit and multiplies this by the amount of demand each characteristic can cause. Another section modifies the demand based on the characteristics of the specific installation being considered. This is the same as figuring 175 gal of water per family per day, but also considers how this installation is different from others. Because the Tabular EEWS has stored, for each installation, an INSTL file which contains data specific to that installation, the output which results from a Tabular EEWS equation is truly specific to the installations being investigated by the user.

This procedure makes an important assumption: characteristic current installation distributions of personnel and materials are likely to continue after the user's "what if?" scenario changes are made. For example:

1. Installations in arid regions are likely to use less water per person due to water conservation emphasis.

2. Installations with no existing family housing are less likely to build new units than installations with an area already devoted to family housing.

3. It probably would be more difficult for an installation with no Vulcan firing ranges to accept them than it would be for another installation with existing ranges to expand their current usage.

These examples are straightforward but, in fact, real distributions can be complicated and subtle. When data for a particular installation are not available or have not been entered yet, the system will default to an Army-wide average value. This may not always be the case, but the approach was adopted for several reasons. It is likely to be a reasonable assumption for most cases. At least it is a better predictive tool than assuming that the simple Army average is appropriate. Further, since the data to support the technique are often available, it lets the user investigate the relative advantages of various alignment changes at different installations.

The next step in the process (or section of the equation) may consider the current surplus of the amount of the descriptor at the installation. In many cases, the installation is actually experiencing a deficit.

In the Tabular EEWS, this is defined simply as a negative surplus. In either case, the installation's expected positive or negative demand is subtracted from the surplus (see the result of Step 3, Figure 4). The result is the new surplus the user can expect based on the moves he has input. These results are available in the Tabular EEWS NEW Surplus or NEWS report (see Step 4, Figure 4 and Figure 6). Also, if the user simply wants to see what the current surplus at an installation is, he can ask for the CURrent Surplus or CURS report (Figure 7).

Step 5 in Figure 4 shows that not all deficits are problems. A critical limit needs to be passed before a deficit becomes large enough to be a problem. For example, at an installation with 30,000 units of bachelor housing suitable for enlisted people, a deficit of 300 housing units projected by an equation is of very little consequence. On the other hand, at a smaller installation with 1000 rather than 30,000 units, a deficit of 300 units is a major problem. To insure the user is alerted to a problem area (called a "red flag") in the second installation but not in the first, the concept of a "threshold" has been incorporated into Tabular EEWS. A threshold is the percentage of the current existing value for a descriptor above which it is unlikely a real problem (i.e., one worth worrying about)

```
REPORT NAME?
I>topic

AGGREGATION?
I>housing                  TOPICAL NEW SURPLUS
-
PERSONNEL AND DEPENDANT HOUSING REQUIREMENTS
```

DESCRIPTOR	ORD	WOOD
PFH/E2-3	0.00	0.00
PFH/E4-6	-390.32	-530.84
PFH/E7-9	-241.62	-117.00
PFH/OF1-3	-87.44	100.63
PFH/OF4-10	-8.59	-6.02
BTH/E1	-3500.00	2253.00
BTH/E2-4	1613.60	-645.22
BTH/E5-6	215.60	27.47
BTH/E7-9	149.97	11.50
BOQ/OF1-2	162.32	103.59
BOQ/OF3-10	-285.16	52.88
FHOFF	-2190.90	97.19
BRUOFF	0.00	22.58

Figure 6. NEWS report example.

CURRENT SURPLUS

DESCRIPTOR	ORD	WOOD
PFH/E2-3	0.00	0.00
PFH/E4-6	-1015.00	889.00
PFH/E7-9	-141.00	-90.00
PFH/OF1-3	-115.00	232.00
PFH/OF4-10	-6.00	0.00
BTH/E1	0.00	2253.00
BTH/E2-4	482.00	837.00
BTH/E5-6	142.00	215.00
BTH/E7-9	159.00	16.00
BOQ/OF1-2	158.00	145.00
BOQ/OF3-10	-283.00	58.00
FHOFF	-2599.00	438.00
BRUOFF	0.00	26.00

Figure 7. CURS report example.

will occur. This percentage is independent of installations and each descriptor could have a unique threshold value. In the calculation procedure, once the descriptor value for the new surplus (NEWS) has been calculated, the corresponding values of current existing from that installation's data file is multiplied by the threshold value:

$$\text{installation}_q \text{ limit}_n = \text{(the current existing amount of Descriptor}_n \text{ at installation}_q) \times \text{(the threshold value}_n \text{ for descriptor}_n) \quad \text{[Eq 3]}$$

Then a test is run to see if the new surplus is greater than that installation's limit. If the NEWS report value (the result of Step 4, Figure 4) is the larger, a problem is likely to have been identified (see Step 5, Figure 4). The result of this last step is presented in the SUMmary or SUM report for a topic area. SUM shows an X (or a "red flag") next to the descriptors where the installation's limit is exceeded. Note that the NEWS report may well show deficits (negative surpluses) which are not reflected by an "X" in the SUM report (Figure 8).

Because individuals at various levels of management need different amounts of detail, an AGGregation of the results or the AGG report is available. The AGG report lists all topic area names, without any descriptors (Figure 9). If the SUM report for a specific topic area has any red flag "X's" for any descriptor, then the line in the AGG report from that topic area will show a "higher order red flag X." It is possible, but not likely, that many or all of the descriptors may show deficits in the NEWS report, but no red flag will result in the AGG report because no deficits exceeded the thresholds and so were not flagged in the SUM report.

REPORT NAME?
1>sum

SUMMARY

DESCRIPTOR	ORD	WOOD
PFH/E2-3		
PFH/E4-6	X	X
PFH/E7-9	X	X
PFH/OF1-3	X	
PFH/OF4-10	X	X
BTH/E1	X	
BTH/E2-4		X
BTH/E5-6		
BTH/E7-9		
BOQ/OF1-2		
BOQ/OF3-10	X	
FHOFF	X	
BRUOFF		
ELEM/ON		X
ELEM/OFF		
HIGHSCHL		X
HOSP BED		X
SEWAGE/ON		
SEWAGE/OFF	X	
105MM HOW		
155MM HOW		X
175MM HOW		
VULCAN		NONE
MORTAR		X
TOW		NONE
TANKSUBCOA		NONE
TANKMAIN	NONE	NONE
AERIALGUN		X
R&E CONF P	PRESENT	
R&E LIK P	PRESENT	PRESENT
R&E POS P	PRESENT	PRESENT
R&E MC P		
R&E CONF S	PRESENT	
R&E LIK S	PRESENT	
R&E POS S	PRESENT	
R&E MC S	PRESENT	

Figure 8. SUM report example.

REPORT NAME?
1>agg

AGGREGATED SUMMARY

DESCRIPTOR	ORD	WOOD
HOUSING	X	X
DEP SCHOOL		X
MEDICAL		X
UTILITIES	X	
RANGES	X	X
RARE&E SP	X	X
HISTORICAL	X	X
ARCHEOLOG	X	X
WATER BOD	X	

Figure 9. AGG report example.

5 THE LOCATION ENVIRONMENTAL EARLY WARNING SYSTEM: AN OVERVIEW

Locational Information in the Planning Process

Although the Tabular EEWS is very flexible in the way it manipulates certain types of information and outputs tables, many questions in environmental planning can only be answered by studying a concern's location, or "nearness," to critical concerns.

For example, an installation may be home to an endangered animal species that is extremely sensitive to human encroachment. Although the animal may be living in a part of the installation that will not be used in a proposed realignment scenario, the Tabular EEWS still may indicate a conflict. But by simply looking at a map, a well-informed Army user would quickly see no problem will occur.

Collecting the maps needed to make this kind of inspection for several installations takes time. It is often left to later in the planning process, perhaps not before an EA or EIS is being written. The Location EEWS lets the user overcome problems of this sort by:

1. Quickly displaying maps for selected categories of data for many installations.

2. Easily manipulating and combining these maps so more sophisticated questions can be analyzed.

There are two important questions which can only be addressed using locational display or information derived from locationally stored data:

1. What considerations occur at the same location (e.g., soils and vegetation)?

2. What considerations have a critical distance from others (e.g., how far is the hospital from a controlled access highway)?

Several answers, at several levels of detail, are possible. At the simplest level, a Location EEWS user can:

1. Ask for a map showing where a concern is found anywhere on an installation, e.g., for the vegetation type. The user also can ask for the map to be presented at one of several scales. These maps include tables which list the quantity of each concern category in cells, acres, or hectares, and the percentage of the total area covered by the items.

2. Ask for a map of a particular portion of the installation.

3. Ask for an English-word output of everything found at a single location (or within any user-defined area).

Problems of adjacency and critical distance are more difficult for users to determine by hand. Thus, the Location EEWS is designed to do distance searches—that is, generate equal-distance contours from a single item or any requested combination of items. A map showing distance relationships can be created and/or the generated data can be stored for use as input for further mapped analysis.

To look into more involved questions, the Location EEWS can take maps and combine them for user-specified factors in each. This is much like a planner taking a current map of the dens of an endangered species, combining this with a map of the animal's distance of travel, and overlaying another map of its preferred food sources in order to show likely areas of critical habitat. The computer can do this easily for any number of maps. It also will put varying importance "weights" on the different items that make up the maps in any way chosen by the users. For example, for a vegetation map, coniferous trees can be 2½ times more important (more "weight") than deciduous trees when a user is trying to determine critical habitat. The mapped result of an involved question can be stored and used as input to another involved question, as if it were just another data map.

Like the Tabular EEWS, the Location EEWS has predefined investigations which can be run on different installations to compare the reallocation effects. To use a predefined model, the user only has to ask for it and name the installations in which he is interested. To place a new land use, part of the Location EEWS stores standard mapped figures (like range safety fans, noise patterns, and foraging ranges). The user can place one of these standard land use patterns at an installation (by computer) and then run the standard suitability or impact analyses against its proposed location.

Original storage of the maps is done by digitizing them; i.e., putting them into computer-readable form. Digitizing may take from a half day of an operator's time for simple considerations (locations of training ranges) to several days' effort (a detailed installation soils map). Each installation may have up to 50 maps stored and available for use. Like tabular data, they are updated as new information becomes available.

Examples

The Location EEWS does its locational analysis by manipulating many small, similarly sized and shaped rectangular areas ("grid cells") overlayed on an installation map. The smallest cell indicates the precision of the data. Cells can be any size the user desires. Cells of 100 or 200 m on an edge are commonly used. The manner in which grid cells are manipulated depends on the instructions the user enters.

The simplest question a user can ask the Location EEWS is "What is here?" The system can give several types of answers to this question.

1. If the user needs to know what data types are available for the installation he has chosen, he asks for the LIST option. LIST will name the kinds of maps available and their associated categories (Figure 10).

2. If the user wants to know more about a category like soil types, a soils map for the whole installation can be printed using the MAP option (Figure 11).

3. If the user is interested in only a particular location or a limited area, the WHAT option will let him investigate this question in several ways. A portion of WHAT, called VARIABLE, lets the user ask for a small

```
C>eeus

 3/ 3/82     15:09:47


COMMAND?
>map
MOUNT OF DISK W89242 AS 192 IN PROGRESS
MOUNT OF DISK W89242 AS 192 COMPLETED

SHORT INSTALLATION NAME?
>ft polk

OPTION?
>list


FOLLOWING ARE MAP LAYERS AND CATEGORIES FOR FT POLK

   7   RED CODKADDED WOOD PECKER NESTING SITES
         1   NESTING SITE

   2   SOILS
         1   3-15% SLOPE, MOD-WELL DRAINED, UNDULATING TO ROLLING DISS. U
         3   3-15% SLOPE, MOD-WELL DRAINED TO WELL, GENTLY TO STRONGLY SL
         4   <3% SLOPE, POORLY DRAINED FLOODPLAIN SOILS
         5   3-15% SLOPE, MOD-WELL DRAINED ON NEARLY LEVEL TO UNDULATING
         6   3-30% SLOPE, WELL DRAINED SOILS ON ROLLING TO STEEPLY SLOPIN

   4   WATER
         1   INTERMITTENT AND FIRST ORDER STREAMS
         2   SECOND ORDER STREAMS
         3   THIRD ORDER STREAMS
         4   FOURTH ORDER STREAMS
         9   NINTH

   3   VEGETATION
         1   CONIFEROUS     OPEN TO MEDIUM
         2   CONIFEROUS     MEDIUM TO DENSE
         3   DECIDUOUS      OPEN TO MEDIUM
         4   DECIDUOUS      MEDIUM TO DENSE
         5   MIXED          OPEN TO MEDIUM
         6   MIXED          MEDIUM TO DENSE
         7   SHORT GRASSES
         8   SWAMPS   WET WITH     50% TREES
         9   CANTONMENT

   9   IMPACT AREAS
         1   IMPACT AREA

   8   TRAINING AREA
         1   FIRING POINTS
         2   TOWERS
         3   UNDERGROUND PIPELINE
         4   TELEPHONE LINE
         5   POWER LINE
         6   BOUNDARY
        Etc.
         :
```

Figure 10. LIST option example.

area of the complete map by specifying the area's northwest and southeast corner coordinates (Figure 12).

4. If the user needs to know what exists in a specific location, he can use another section of WHAT, called CATEGORY. CATEGORY asks the user to enter the coordinate of a particular location and then gives him an English-word printout about what occurs at that location for each of the maps stored for the installation (Figure 13).

5. If the user wants an English-word list of every category for every map which contains information on the requested rectangle, he asks for the AREA portion of the WHAT option and enters the northwest and southeast corners of his area of interest (Figure 14).

Many users need to continuously update their stored data. The Location EEWS offers two storage update options.

1. MODIFY lets the user change data stored in a particular location or area by entering the edges of the area; the user then can enter his new data (Figure 15). MODIFY is particularly valuable because it is so easy to use.

2. ALTER lets the user change the parameters (including the legend) which define a map. Thus, the

Figure 11. MAP option example.

```
TEST NO. 1
BASE DATA DISPLAY
DATA VARIABLE NO. 3 WEST POINT SOILS
CATEGORIES
----------
1      POORLY GRADED GRAVEL, POORLY GRADED SAND, AND SILTY SAND, STRATIF
2      SILTY SAND
3      SILT, IN PLACES OVER SILTY SAND
4      SILTY CLAY, IN MANY PLACES OVER SILT AND SILTY SAND
5
6      SILT AND SILTY SAND, LESS THAN SIX FEET AND COMMONLY STONEY
       AND BOULDERY
7      PEAT
8
9      WATER
```

NOTE: FREQUENCY AND PERCENT of areas are part of output; ACRAGE will be added

DATA VALUE EXTREMES ARE 1.000 9.000

LEVEL NUMBER	SYMBOL	VALUE RANGE	PERCENT VALUE RANGE	FREQUENCY	PERCENTILE RANGE	PERCENT OF AREAS	ACRAGE
LOW		1.000 1.000		0	0.00 0.00	0.00	
1	....	1.000 1.889	11.11	748	0.00 6.81	6.81	
2	//////// //////// ////////	1.889 2.778	11.11	418	6.81 10.61	3.80	
3	00000000 00000000 00000000	2.778 3.667	11.11	1810	10.61 27.08	16.47	
4	++++++++ ++++++++ ++++++++	3.667 4.556	11.11	166	27.08 28.59	1.51	
5	XXXXXXXX XXXXXXXX XXXXXXXX	4.556 5.444	11.11	0	28.59 28.59	0.00	
6	######## ######## ########	5.444 6.333	11.11	6773	28.59 90.22	61.63	
7	@@@@@@@@ @@@@@@@@ @@@@@@@@	6.333 7.222	11.11	372	90.22 93.60	3.38	
8	@@@@@@@@ @@@@@@@@ @@@@@@@@	7.222 8.111	11.11	0	93.60 93.60	0.00	
9	@@@@@@@@ @@@@@@@@ @@@@@@@@	8.111 9.000	11.11	703	93.60 100.00	6.40	
HIGH		9.000 9.000		0	100.00 100.00	0.00	

Figure 11. (Cont'd).

```
VARIABLE,CATEGORY OR AREAS ?
>variable

LAYER NUMBER ?
>2        (Soils Types)

NW CORNER COORDINATES?
>1,95

SE CORNER COORDINATES?
>7,125

THE AREA BOUNDED BY   7, 95 EAST TO   7,125 AND   1, 95 SOUTH TO   7, 95      CONTAINS:

  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 3 3 3 3 3 3 3 3 3 3 3 3 3
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3
  0 0 0 0 0 0 0 0 0 0 0 0 0 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3
  0 0 0 0 0 0 0 0 0 0 0 0 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3
  0 0 0 0 0 0 0 0 0 0 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3

NW CORNER COORDINATES?
>exit
```

Figure 12. WHAT/VARIABLE option example.

legend can be altered to reflect new needs or the symbols can be changed to emphasize specific categories of interest (Figure 16).

The Location EEWS offers several modeling choices through its DEFINE option. DEFINE has several parts: LIST, DIST, ATT, IMP, and COIN.

LIST is the same as the LIST option described above. It is provided in both places because users often begin work on DEFINE before they realize they need a list of categories with which to work.

DIST lets the user generate equal-distance contours. Distance contours can be drawn from one or more items within a particular map, or the items can be taken from several different maps. For example, assume a user asks "Where are the potential archeological sites at Fort Irwin?" Since distance from water sources is a limiting factor, DIST would generate a map showing the distance from springs (Figure 17). The result of such distance analyses can be stored in the Location EEWS database for further analyses.

ATT is one of the most powerful tools within the Location EEWS. ATT searches for attractive, suitable, or desirable locations for a contemplated use. For example, the question "Where are the potential archeological sites?" could be rephrased as "Where are the most attractive locations for prehistoric humans to have lived?" In this form, a user can generate site criteria easily:

1. Close to water sources (see Figure 17).

2. Near steep slopes for cover (a distance determination).

3. On a northerly facing slope for shade from the intense desert sun.

4. In a surficial geologic type which would be preferred and which would have preserved the archeological imprint.

These criteria are then translated into relative importance numbers (weighting factors) for each category

```
OPTION?
>what

VARIABLE,CATEGORY OR AREAS ?
>category

WHERE(R/C)?
>3,120

ROW 3, COLUMN 120 CONTAINS:

          3 3-15% SLOPE, MOD-WELL DRAINED TO WELL, GENTLY TO STRONGLY SL
          1 CONIFEROUS     OPEN TO MEDIUM
          4 600-800    METERS
          4 85-89 DB
          9 FOREST CONIFEROUS, COMMERCIAL/TRAINING
          4 3 - 5%
          5 280 - 300 METERS
          1 EMPTY

WHERE(R/C)?
>3,125

ROW 3, COLUMN 125 CONTAINS:

          3 3-15% SLOPE, MOD-WELL DRAINED TO WELL, GENTLY TO STRONGLY SL
          2 SECOND ORDER STREAMS
          1 CONIFEROUS     OPEN TO MEDIUM
          8 1400-1600 METERS
          8 105 -109 DB
          9 FOREST CONIFEROUS, COMMERCIAL/TRAINING
          3 1 - 3%
          3 240 - 260 METERS
          1 EMPTY

WHERE(R/C)?
>exit
```

Figure 13. WHAT/CATEGORY option example.

```
VARIABLE,CATEGORY OR AREAS ?
>areas

NW CORNER COORDINATES?
>1,95

SE CORNER COORDINATES?
>7,125


THE AREA BOUNDED BY   7, 95 EAST TO   7,125
   AND   1, 95 SOUTH TO   7, 95   CONTAINS:

  RED CODKADDED WOOD PECKER NESTING SITES

        1 NESTING SITE

  SOILS

        3 3-15% SLOPE, MOD-WELL DRAINED TO WELL,
          GENTLY TO STRONGLY SL
  WATER

        1 INTERMITTENT AND FIRST ORDER STREAMS
        2 SECOND ORDER STREAMS
        3 THIRD ORDER STREAMS

  VEGETATION

        1 CONIFEROUS     OPEN TO MEDIUM
        2 CONIFEROUS     MEDIUM TO DENSE
        6 MIXED          MEDIUM TO DENSE
        7 SHORT GRASSES

TRAINING AREA

        6 BOUNDARY

DISTANCE FROM COCKADDED WOODPECKER NESTING SITES

        1 0 - 200    METERS
        2 200-400    METERS
        3 400-600    METERS
        4 600-800    METERS
        5 800-1000   METERS
        6 1000-1200 METERS
        7 1200-1400 METERS
        8 1400-1600 METERS
        9 1600-1800 METERS
       10 1800-2000 METERS
       11 2000-2200 METERS
       12 2200-2400 METERS
       13 2400-2600 METERS

NOISE

        1 70-74 DB
        2 75-79 DB
        3 80-84 DB
        4 85-89 DB
        5 90-94 DB
```

Figure 14. WHAT/AREA option example.

on each needed map (Figure 18). The weighting factors are submitted to the computer using ATT, which generates a result (Figure 19). Figure 19 is not a final answer to the question of possible archeological sites, but it does clearly limit where sites are likely to be found. On very large installations, this map can help focus direct field reconnaissance, saving time, effort, and expense.

By correctly stating the problem, "negative" effects can also be attacked using ATT. For example, erosion vulnerability can be restated as "Where are the most likely (attractive) locations for erosion to occur?" An ATT-generated map for erosion potential at the U.S. Military Academy, West Point, NY is shown in Figure 20.

IMP is designed to do impact modeling. It combines user-selected maps in a manner similar to an ATT analysis. However, with IMP, importance weight effects are increased very quickly; in ATT, effects are increased slowly. To use IMP, the user must have a clear idea of how the potential impact problem must be defined. ATT inputs are easier to define and ATT can combine many maps; IMP is limited to combining three maps.

```
VARIABLE,CATEGORY OR AREAS ?
>variable          Inspect area before starting to modify it.

LAYER NUMBER ?
>7                 (Endangered species locations)

NW CORNER COORDINATES?
>1,100

SE CORNER COORDINATES?
>3,105

THE AREA BOUNDED BY   3,100 EAST TO   3,105 AND   1,100 SOUTH TO   3,100      CONTAINS:


  0 0 0 0 0 0
  0 0 0 0 0 0                   Existing Data in Area to be Modified
  0 0 0 0 0 0

NW CORNER COORDINATES?
>exit

VARIABLE,CATEGORY OR AREAS ?
>exit

OPTION?
>modify               Begin Modifications

LAYER NUMBER ?
>7

LIMITS?
>?
 PLEASE ENTER IN ORDER THE FOLLOWING:
 BEGINNING ROW,ENDING ROW,BEGINNING COLUMN,AND ENDING COLUMN
 OR ENTER-EXIT-TO EXIT THIS OPTION.

LIMITS?
>1,3,100,105

   PLEASE ENTER NEW DATA FOR LOCATION DEFINED:

             1   1   1   1   1   1
    COLS:--  0   0   0   0   0   0
  ROWS:      0   1   2   3   4   5
      1      0   0   0   0   0   0 <--- Existing data for row #1
>0 0 1 1 1 0 <------------------------- User input of new data
      1      0   0   1   1   1   0 <--- Computer tells you this is what you have entered
      2      0   0   0   0   0   0 <--- Existing data for row #2
>1 1 1 1 1 1 <------------------------- User input
      2      1   1   1   1   1   1      Etc.
      3      0   0   0   0   0   0      :
>1 1 0 0 0 1
      3      1   1   0   0   0   1

LIMITS?
>exit                               Finished

LAYER NUMBER ?
>exit

OPTION?
>what

VARIABLE,CATEGORY OR AREAS ?
>variable                           Inspect area after modification

LAYER NUMBER ?
>7

NW CORNER COORDINATES?
>1,100

SE CORNER COORDINATES?
>3,105

THE AREA BOUNDED BY   3,100 EAST TO   3,105 AND   1,100 SOUTH TO   3,100      CONTAINS:


  0 0 1 1 1 0
  1 1 1 1 1 1                       Newly entered data
  1 1 0 0 0 1

NW CORNER COORDINATES?
>exit

VARIABLE,CATEGORY OR AREAS ?
>exit
```

Figure 15. MODIFY option example.

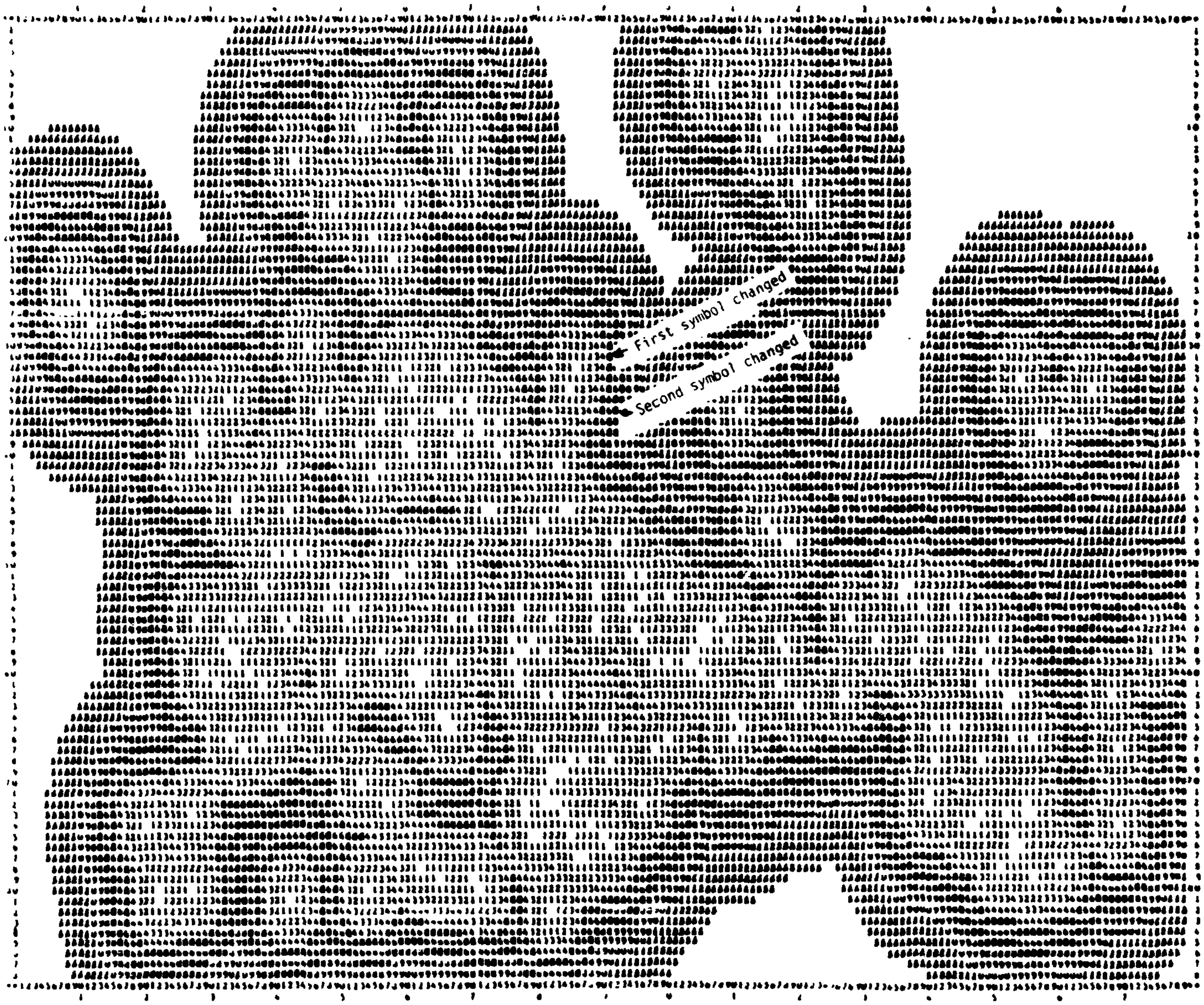

Figure 16. ALTER option example.

COIN lets the user find the frequency of coincidence in tabular format between the items stored in two or three maps. The resulting frequencies can be important themselves or can be used as input to an IMP or ATT model. Figure 21 shows the input needed to generate a simple table of endangered species vs vegetation.

DIST, ATT, and IMP results can be stored as maps in an installation data file and then used as input maps in other analyses.

Another main Location EEWS option, called LANDUSE, lets the user place new land uses in proposed locations at his selected installations. Land uses can be a single unit like "office building" (consisting of only one grid cell); large, complex areas like firing fans and safety zones; noise patterns associated with aerial

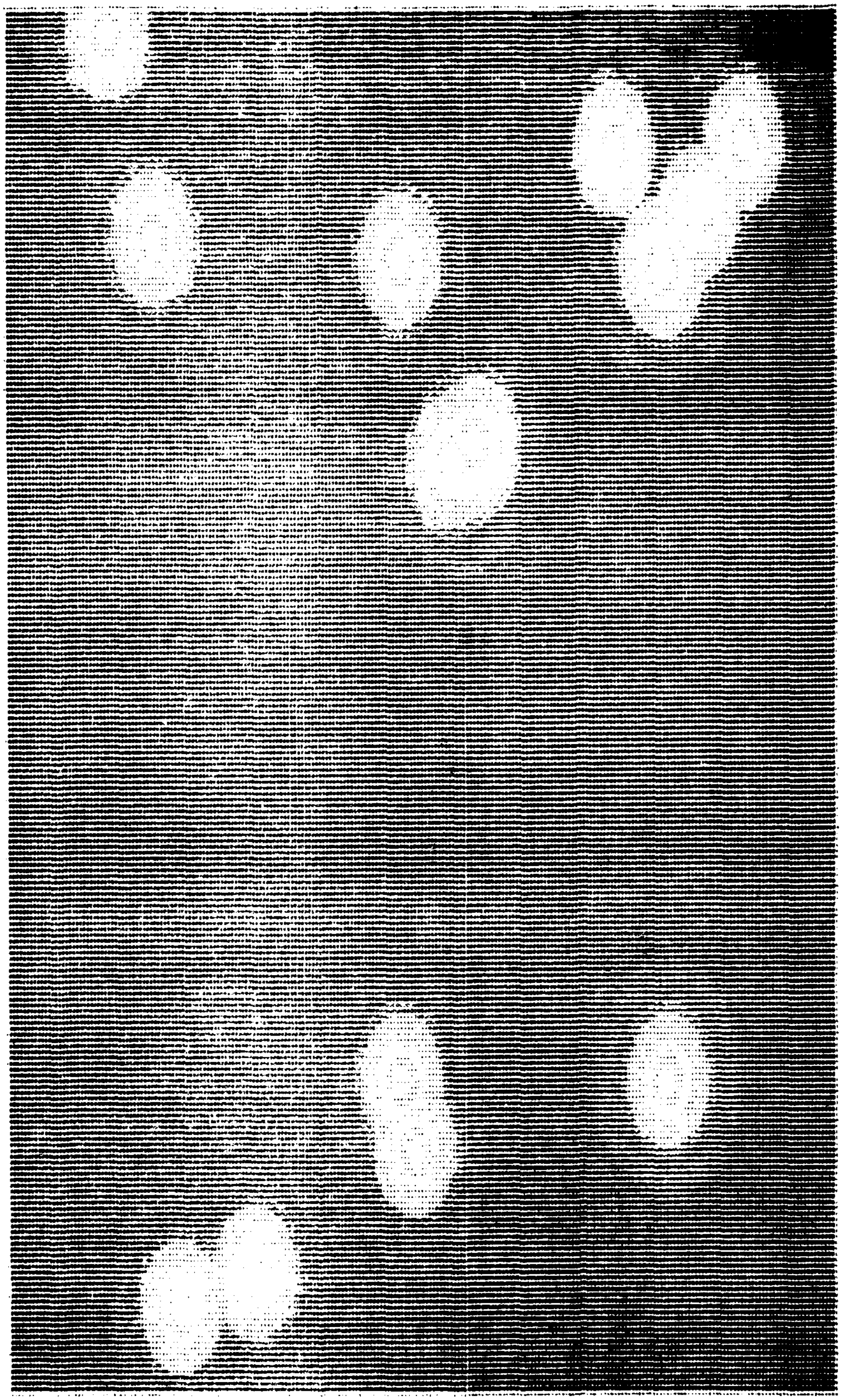

Figure 17   DIST option example

Importance Weights (the greater value, the more attractive)

THE FOLLOWING DATA VARIABLES ARE IN THE MODEL

VAR ID	RECODING FOR CLASSES 1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	INDEX WEIGHT	VARIABLE
12	0	3	3	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	GOOD SLOPES
13	0	-1	-1	1	2	-2	-2	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	SHADED ASPECTS
5	0	-1	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	DESIRED GEOLOGY
14	0	5	5	4	4	3	3	2	2	1	1	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	1.00	DST FRM SPRINGS
15	0	3	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	DST FRM HI SLP

Figure 18. Weighting factors used in potential archeological site analysis.

assault equipment; or the normal hunting ranges of mountain lions. After the user defines where the new land use is to be located, this land use placement is stored as a map. This map can then be combined with any other maps using the DIST, ATT, IMP, or COIN options of DEFINE.

The Location EEWS is usually used to find how a proposed change in an installation's traditional land use pattern may cause an environmental impact. The method is similar to standard planning practices, but the computer allows faster, more detailed analysis at an earlier planning stage. First, good locations for the new use are found using ATT. Then, the new use is placed using LANDUSE in the best locations indicated by the ATT analysis. Next, the impacts those placements may cause are modeled using IMP or ATT.

These steps quickly and objectively compare relative qualities and trade off alternatives at the same installation or among different installations.

One of the simplest and most useful of the unique capabilities offered by the Location EEWS is that of the predefined models. Since the input needed for ATT and IMP models may require more expertise or time than the average user can provide, the Location EEWS offers two options which contain many predefined analysis models applicable to several installations: SUITAB(ility) and IMPACT. In these predefined models, the user need only either:

1. Ask for the desired predefined model, or

2. Place the new land use in a proposed location using the LANDUSE option (if needed) and run the predefined model (Figure 22).

Because these predefined models can be used for

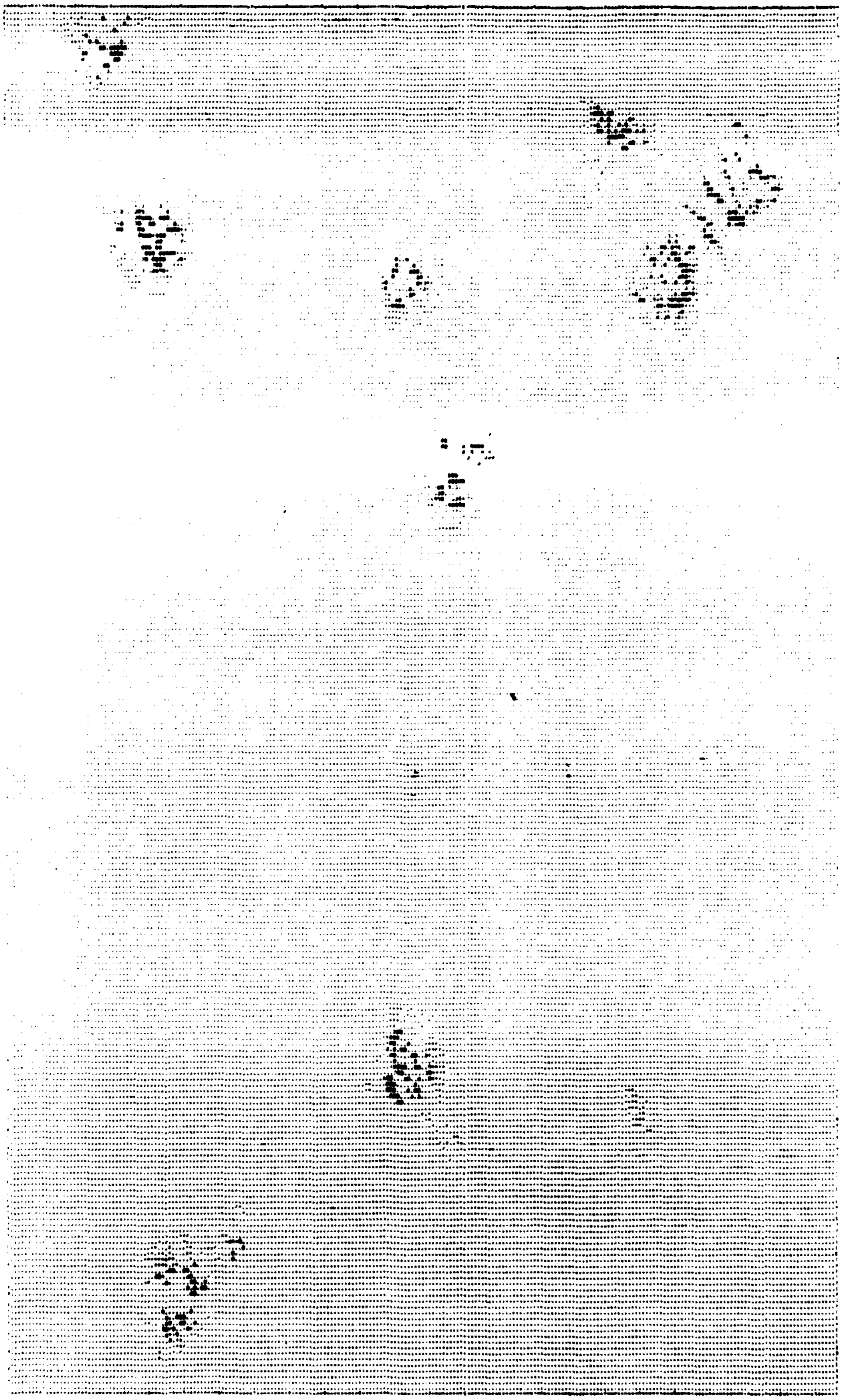

Figure 19. Potential archeological sites–Fort Irwin.

several installations in a variety of problem situations, they are general in nature. However, they are very easy to use, especially for users accessing the Location EEWS for the first time.

Figure 23 shows how easily a new model can be created if the user wishes to develop his own.

6 CONCLUSION

The concept for the EEWS described in this report can give HQDA, MACOM, and other Army decision-makers the information they need to identify, at the very earliest stages of planning, potentially serious environment-related problems associated with changes in troop strength, mission, facilities, natural resource management, and land use.

System data are installation-specific and derived from the most accurate HQDA and MACOM sources available.

No computer experience is needed to use the system.

The system can be used to consider almost any environment-related question, as long as the question can be expressed as a single, or series, of algebraic equations.

The system can analyze, in detail, multiple considerations or an aggregation of several impacts. Location-specific data for each installation also are available.

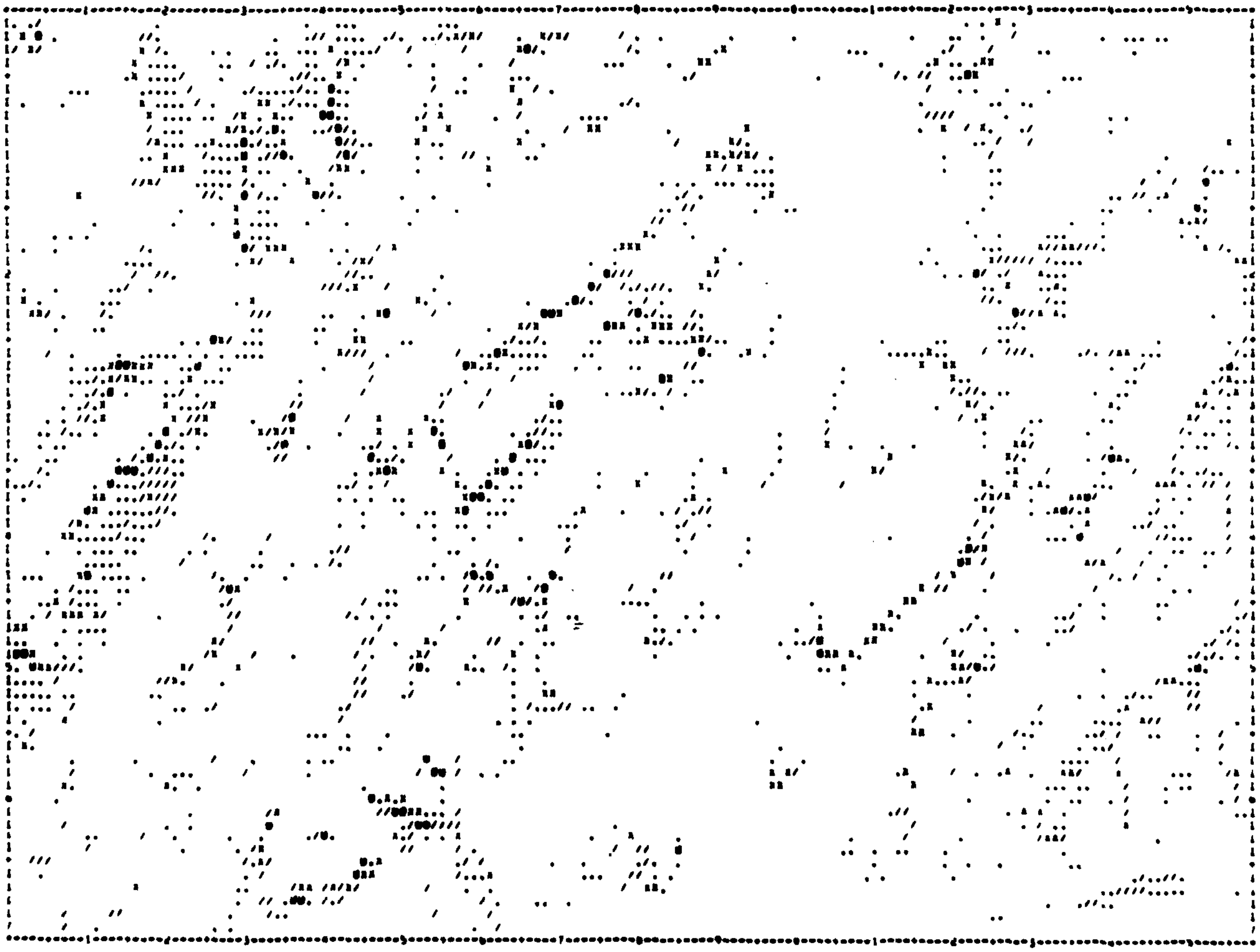

Figure 20. Erosion potential, U.S. Military Academy, West Point, NY.

```
DEFINE OPTION?
>coin

TITLE?
>woodpecker/vegetation

NEXT?
>?
TYPE:     TO:
G1        DEFINE THE CATEGORIES FOR GROUP 1
G2        DEFINE THE CATEGORIES FOR GROUP 2
G3        DEFINE THE CATEGORIES FOR GROUP 3
OPTS      TO SPECIFY THE OUTPUT UNITS
SEE       TO SEE WHAT HAS CURRENTLY BEEN SPECIFIED
LIST      TO SEE EXISTING MAP LAYERS AND CATEGORIES
EXIT      ABORT THE DEFINITION OF COINCIDENT TABULATIONS
DONE      LEAVE THIS SECTION AND SUBMIT INPUTS

NEXT?
>g1

MAP AND CATEGORIES?
>7,1

YOU HAVE CHOSEN:    GROUP I

LAYER  7: RED COCKADDED WOOD PECKER NESTING SITES
CATEGORIES:
             1 - NESTING SITE

NEXT?
>g2

MAP AND CATEGORIES?
>?
 ENTER THE NUMBER CODE OF A MAP LAYER FOLLOWED BY THE NUMBER
 CODES OF THE CATEGORIES ASSOCIATED WITH THAT MAP FROM WHICH
 COINCIDENCE TABULATIONS WILL BE GENERATED.

MAP AND CATEGORIES?
>3,1,2,3,4,5,6,7,8,9,

YOU HAVE CHOSEN:    GROUP II

LAYER  3: VEGETATION
CATEGORIES:
             1 - CONIFEROUS     OPEN TO MEDIUM
             2 - CONIFEROUS     MEDIUM TO DENSE
             3 - DECIDUOUS      OPEN TO MEDIUM
             4 - DECIDUOUS      MEDIUM TO DENSE
             5 - MIXED          OPEN TO MEDIUM
             6 - MIXED          MEDIUM TO DENSE
             7 - SHORT GRASSES
             8 - SWAMPS    WET WITH     50% TREES
             9 - CANTONMENT
```

```
NEXT?
>see

COINCIDENT TABULATION SETUP:

---------------------------------------------------------------------
TABLES ARE TO BE GENERATED SHOWING THE COINCIDENCE BETWEEN THESE
  CATEGORY GROUPS:

  GROUP 1                              GROUP 2
  MAP VARIABLE: RED COCKADDED WOOD P   MAP VARIABLE: VEGETATION
  CATEGORIES  :                        CATEGORIES  :
  1 - NESTING SITE                     1 - CONIFEROUS     OPEN TO MEDIU
                                   2 - CONIFEROUS     MEDIUM TO DEN
                                   3 - DECIDUOUS      OPEN TO MEDIU
                                   4 - DECIDUOUS      MEDIUM TO DEN
                                   5 - MIXED          OPEN TO MEDIU
                                   6 - MIXED          MEDIUM TO DEN
                                   7 - SHORT GRASSES
                                   8 - SWAMPS    WET WITH     50% TR
                                   9 - CANTONMENT

---------------------------------------------------------------------
SEPARATE TABLES WILL BE CREATED SHOWING THE COINCIDENCE OF THESE GROUPS
WITHIN EACH OF THE FOLLOWING CATEGORIES:

  GROUP 3
  MAP VARIABLE:
  CATEGORIES  :
      NOT DEFINED YET

---------------------------------------------------------------------
TABLES WILL BE GENERATED SHOWING THE COINCIDENCE RESULTS IN
TERMS OF HECTARES (DEFAULT).  ADDITIONAL TABLE OPTIONS MARKED WITH
AN ASTERISK HAVE ALSO BEEN REQUESTED:
      PERCENTAGE OF GROUP 1
      PERCENTAGE OF GROUP 2
      PERCENTAGE OF TOTAL GROUPING

---------------------------------------------------------------------

NEXT?
>exit
```

Figure 21. COIN input needed to generate endangered species vs vegetation.

COINCIDENCE TESTING
RED COCKADED WOODPECKER
VERSUS VEGETATION TYPES

0

COINCIDENTS MATRIX

ROW	COLUMN 1	2	3	4	5	6	7	8	9	10	ROW TOTAL
1	48.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.0
2	18.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.9
4	.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	.4
5	5.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.5
6	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.1
7	19.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.3
9	.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	.8
TOTAL	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0

ROW CATEGORIES ARE VEGETATION TYPE

1 CONIFERS-OPEN TO MEDIUM
2 CONIFERS-MEDIUM TO HIGH
3 DECIDIOUS-OPEN TO MEDIUM
4 DECIDIOUS-MEDIUM TO HIGH
5 MIXED-OPEN TO-MEDIUM DEN
6 MIXED-MEDIUM TO HIGH DEN
7 SHORT GRASSES
8 SWAMPS AND WET AREAS WIT
9 CANTONMENT AREAS

COLUMN CATEGORIES ARE BIRD LOCATIONS

1 WOODPECKER NEST LOCATION
2 OTHERS
3
4
5
6
7
8
9

INTERPRETATION: 48% of the birds are located in open to medium density coniferous vegetation while 19.3% are in short grass areas.

** NOTE ** PERCENTAGE OF TOTAL AREA

Figure 21. (Cont'd).

```
C>eews

 3/ 3/82     15:02:50

COMMAND?
>map
MOUNT OF DISK W89242 AS 192 QUEUED
MOUNT OF DISK W89242 AS 192 IN PROGRESS
MOUNT OF DISK W89242 AS 192 COMPLETED

SHORT INSTALLATION NAME?
>ft polk

OPTION?
>landuse

WHAT LAND-USE PATTERN?
>2      (Multi-Purpose Firing Range for M-1 Tank)

ENTER X,Y PIVOT POINT OF STANDARD MAP
>240 125

ENTER X,Y PIVOT POINT FOR FINAL MAP
>60 130

ENTER ANGLE OF ROTATION
>45
ROTATION IN PROGRESS...
THE ROTATED DATA IS NOW STORED IN LAYER 1 OF FT POLK

OPTION?
>impact

THIS IMPACT ANALYSIS WILL USE LANDUSE PATTERN :
RANGE, M1, 3 LANE MANEUVER

IS CURRENT LANDUSE APPROPRIATE FOR YOUR SUITABILITY RUN?
>yes

FOR WHAT CANNED MODEL?
>imptank1    (The name of the Pre-defined Model)
```

Figure 22. Input needed to run a locational predefined model for M-1 tank impacts.

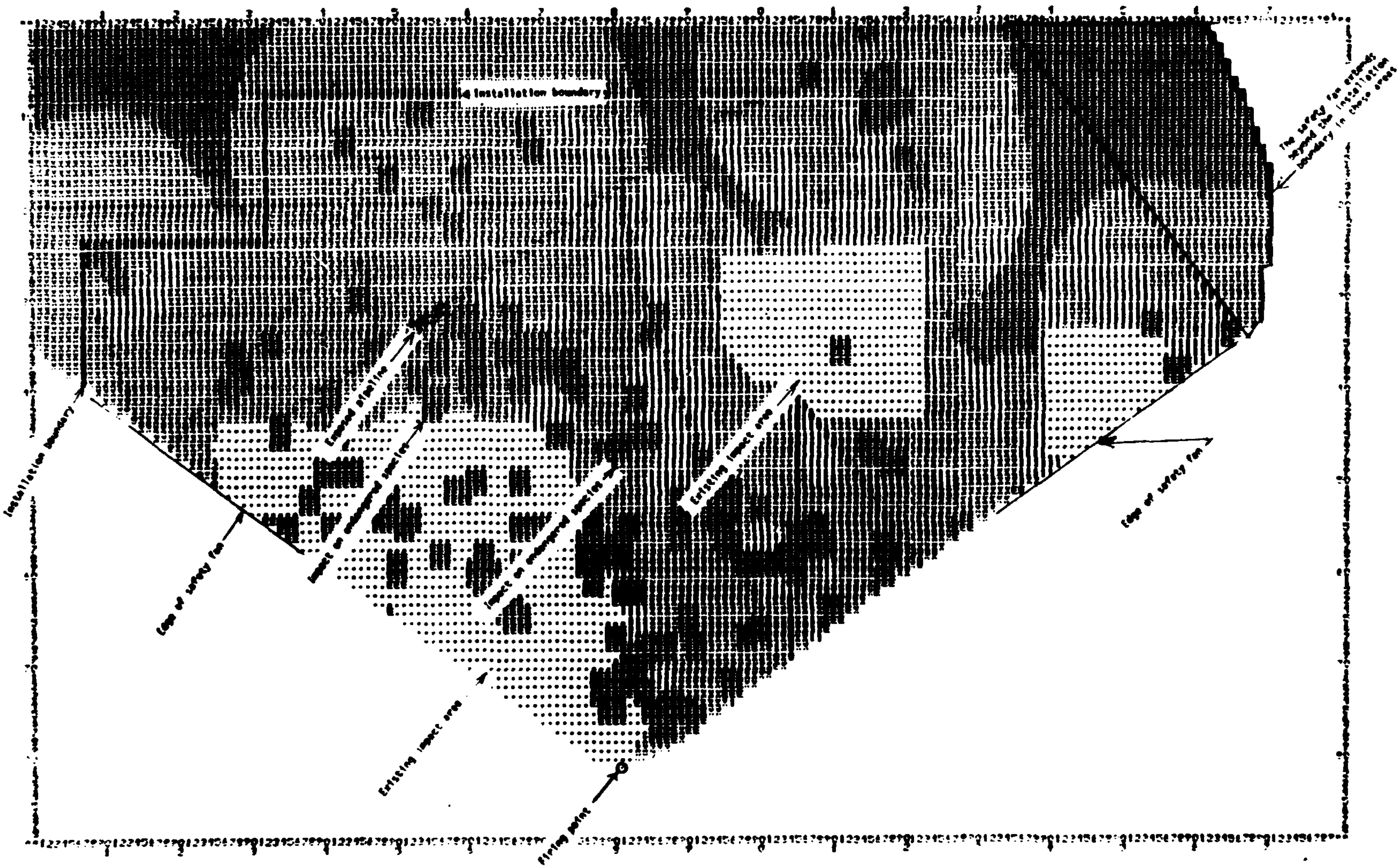

Figure 22. (Cont'd).

```
DEFINE OPTION?
 all

ATTRACTIVENESS OPTION?
 ?
 ENTER  TO
 -----  --
  VAR   ADD VARIABLES TO BE CONSIDERED
  SEE   SEE CURRENT VARIABLES AND CATEGORY WEIGHTINGS
  WVAR  ASSIGN WEIGHTS TO VARIABLES
  WCAT  ASSIGN WEIGHTS TO CATEGORIES
  END   SUBMIT CURRENT WEIGHTINGS
  EXIT  ABORT THE CURRENT ATTRACTIVENESS SESSION

ATTRACTIVENESS OPTION?
 var

WHAT VARIABLE?
 3   (Vegetation defined as first input)

ATTRACTIVENESS OPTION?
 wvar

VARIABLE WEIGHT?
 ?
 SPECIFY IN ORDER:
   THE VARIABLE TO BE WEIGHTED AND
   THE WEIGHT.THIS MUST BE A DECIMAL NUMBER.
 ENTER -EXIT- TO END VARIABLE WEIGHT ASSIGNMENTS

VARIABLE WEIGHT?
 3 1.0   (Importance of vegetation map relative to
                        other maps is 1.0)
ATTRACTIVENESS OPTION?
 wcat        (Now define the relative important of the
                     categories in the vegetation map)
CATEGORY WEIGHT?
 ?
 SPECIFY IN ORDER:
 THE VARIABLE TO WHICH THE CATEGORY BELONGS,
 THE CATEGORY OF INTEREST, AND
 THE WEIGHT. THIS MUST BE AN INTEGER BETWEEN -1 AND 10 INCLUSIVE.

   NOTE THAT -1 SIGNIFIES THAT ALL CELLS WITH THIS CATEGORY BE
   REJECTED FROM THE ANALYSIS.

CATEGORY WEIGHT?
 3 1 2   (For  the vegetation map (3) the 1st category
                  has an importance of 2)
CATEGORY WEIGHT?
 3 2 1   (For the vegetation map (3) the 2nd category
                  (coniferous-medium to dense coverage)
CATEGORY WEIGHT?  has less importance (1 rather than 2))
 1 ? ?     (Etc.)

CATEGORY WEIGHT?
 3 9 -1

CATEGORY WEIGHT?
 exit  (Done with vegetation map)

ATTRACTIVENESS OPTION?
 var

WHAT VARIABLE?
 5     (Distance from nesting sites)

ATTRACTIVENESS OPTION?
 wvar

VARIABLE WEIGHT?
 5 .5   (Importance of nesting sites map relative to others
                        (vegetation) is less (.5 rather
ATTRACTIVENESS OPTION?   than 1.0))
 wcat

CATEGORY WEIGHT?
 5 1 4    (For the nesting sites map (5) the 1st category
                  (closest) has high imporence (4))
CATEGORY WEIGHT?
 5 2 4    (For the nesting sites map the 2nd category is
                             also important (4))
CATEGORY WEIGHT?
 5 3 4
```

```
CATEGORY WEIGHT?
>5 4 2      (Etc.)

CATEGORY WEIGHT?
 5 5 2

CATEGORY WEIGHT?
 5 6 -1   (For  nesting sites, do not even consider as forag-
                ing areas farther away than category 6
CATEGORY WEIGHT?   (1 kilometer))
>5 7 -1   (Etc.)

CATEGORY WEIGHT?
>5 8 -1

CATEGORY WEIGHT?
>5 9 -1

CATEGORY WEIGHT?
>5 10 -1

CATEGORY WEIGHT?
>5 11 -1

CATEGORY WEIGHT?
>5 12 -1

CATEGORY WEIGHT?
 5 13 -1

CATEGORY WEIGHT?
>5 14 -1

CATEGORY WEIGHT?
>5 15 -1

CATEGORY WEIGHT?
>exit    (Done defining model)

ATTRACTIVENESS OPTION?
>see     (Let us inspect the model just defined)

   MAP LAYER  3 -- VEGETATION

        1  CONIFEROUS     OPEN TO MEDIUM
        2  CONIFEROUS     MEDIUM TO DENSE
        3  DECIDUOUS      OPEN TO MEDIUM
        4  DECIDUOUS      MEDIUM TO DENSE
        5  MIXED          OPEN TO MEDIUM
        6  MIXED          MEDIUM TO DENSE
        7  SHORT GRASSES
        8  SWAMPS   WET WITH     50% TREES
        9  CANTONMENT

   MAP LAYER  5 -- DISTANCE FROM COCKADED WOODPECKER NESTING SITES

        1  0 - 200    METERS
        2  200-400    METERS
        3  400-600    METERS
        4  600-800    METERS
        5  800-1000   METERS
        6  1000-1200  METERS
        7  1200-1400  METERS
        8  1400-1600  METERS
        9  1600-1800  METERS
       10  1800-2000  METERS
       11  2000-2200  METERS
       12  2200-2400  METERS
       13  2400-2600  METERS
       14  2600-2800  METERS
       15  2800 -
```

THE FOLLOWING DATA VARIABLES HAVE BEEN DEFINED

VAR ID	CATEGORIES 1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	VAR WGT
3	2	1	0	0	0	0	1	0	-1	0	0	0	0	0	0	1.0
5	4	4	4	2	2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0.5

Figure 23. Creating a Location Environmental Early Warning System model--example.

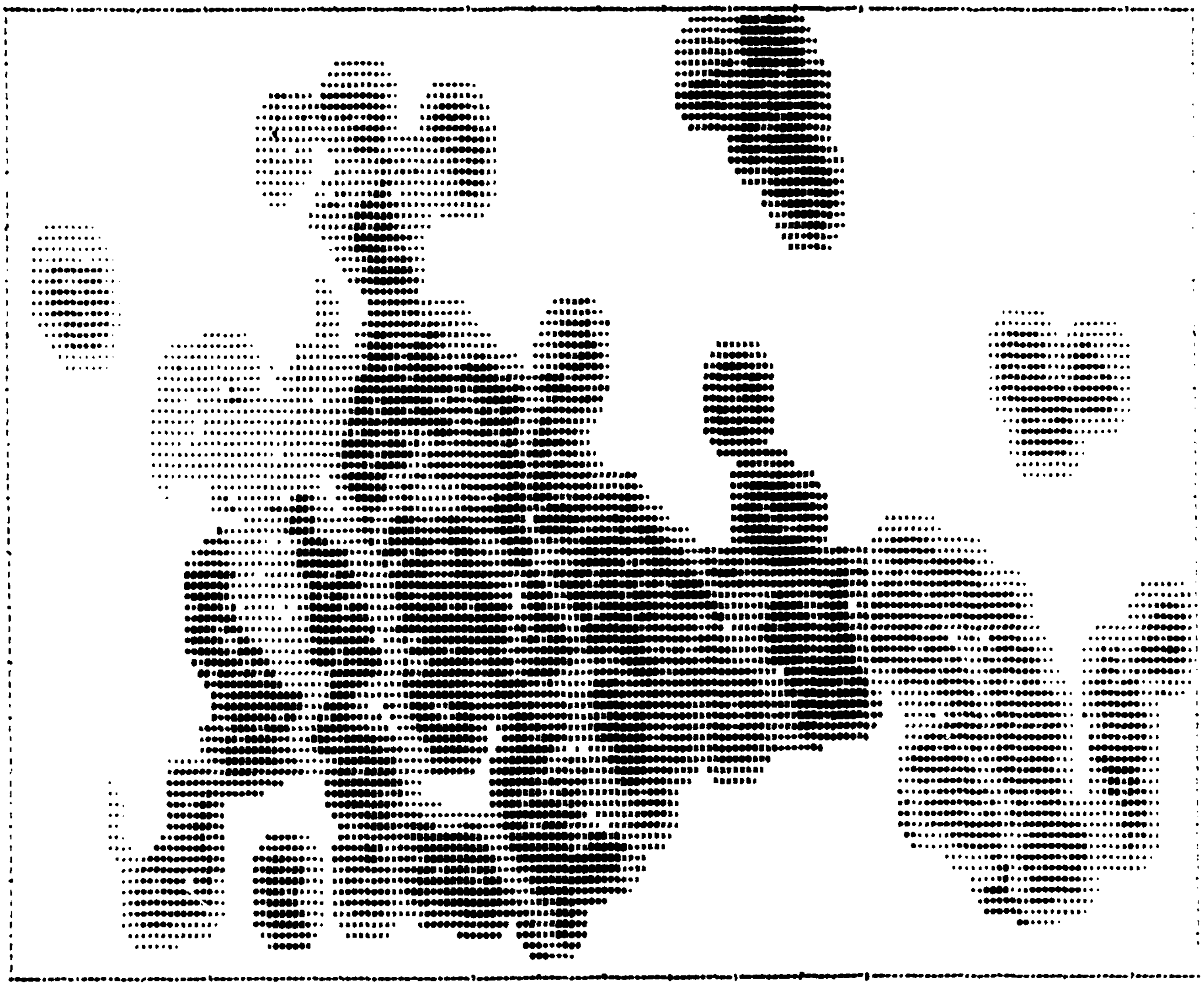

Figure 23. (Cont'd).

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